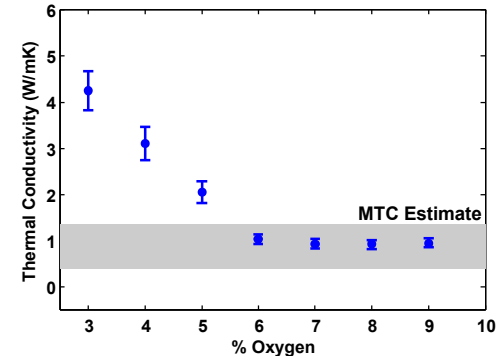
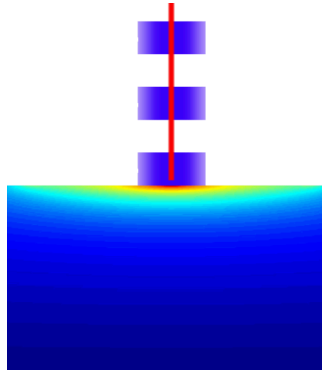
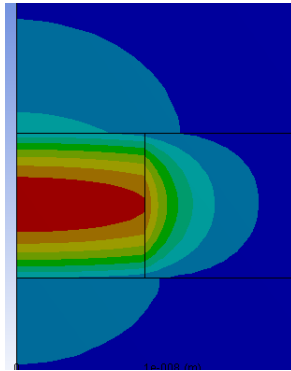
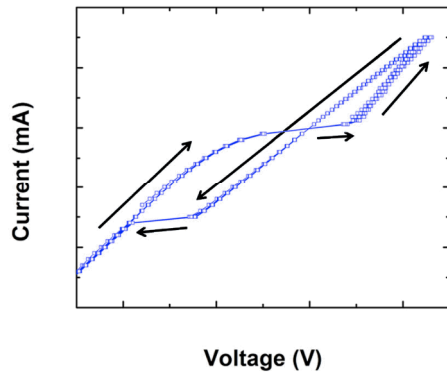


Exceptional service in the national interest



Thermal Transport in TaO_x Films for Memristive Applications

Stoichiometric Control of Dominant Thermal Carriers

Colin Landon & Thomas Beechem

Team: Rudeger H.T. Wilke
Michael Brumbach
Geoff Brennecke
Mia Blea-Kirby
Jon Ihlefeld
Matt Marinella

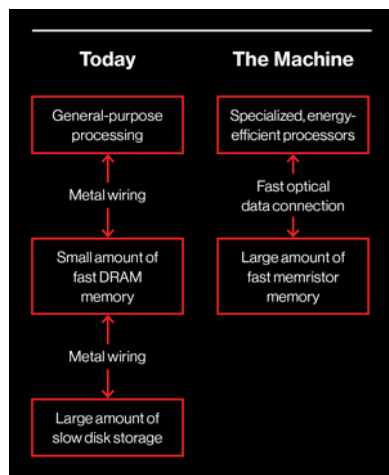
Memristors & Temperature

FEATURED STORY

Machine Dreams

To rescue its struggling business, Hewlett-Packard is making a long-shot bid to change the fundamentals of how computers work.

By Tom Simonite on April 21, 2015



MIT Technology Review

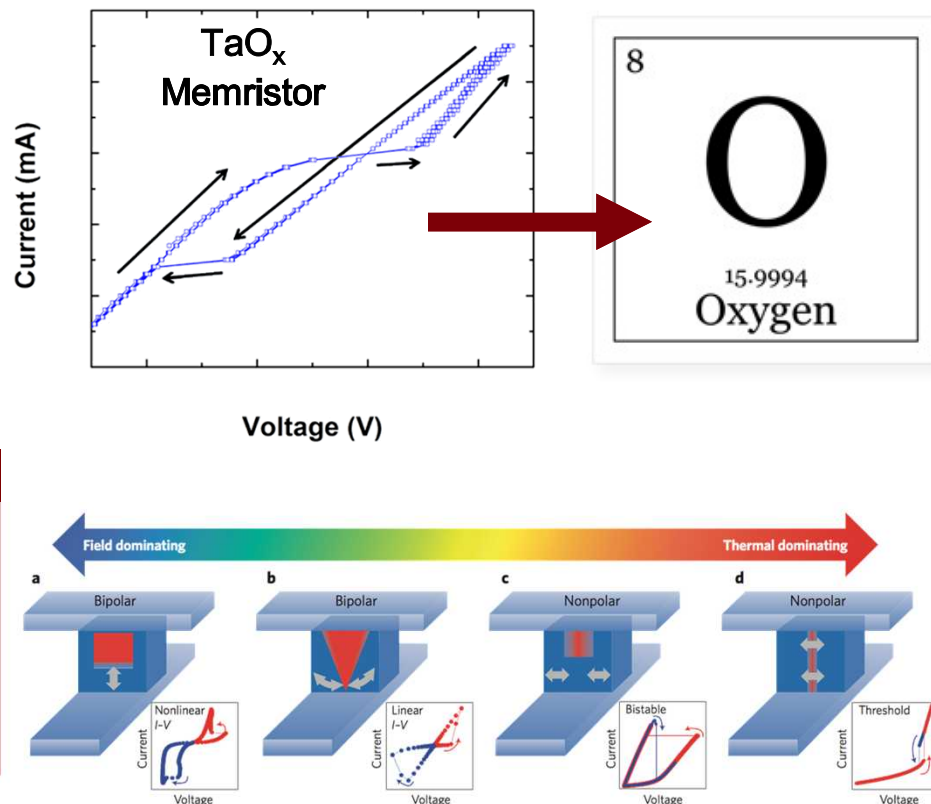


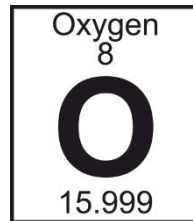
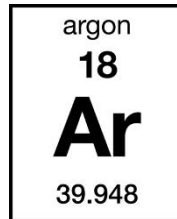
Figure: Yang et al. Nature Nano (8) 13. 2013

GUIDING QUESTIONS

1. What is the thermal conductivity of TaO_x used in memristor?
2. Is there an easy way to predict this value?

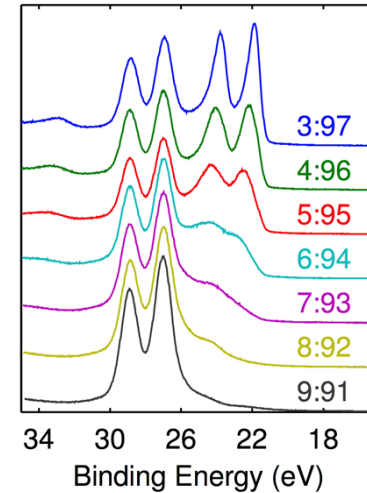
Method & Approach

Variable Stoichiometry TaO_x

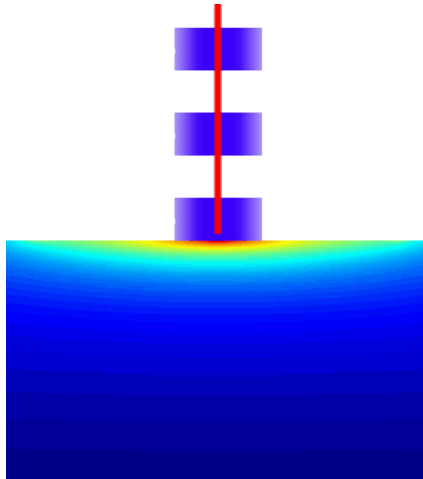


Change O₂ During Deposition

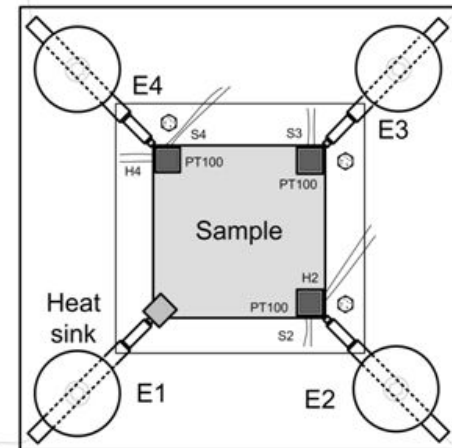
Stoichiometry XPS



TDTR: Thermal Conductivity

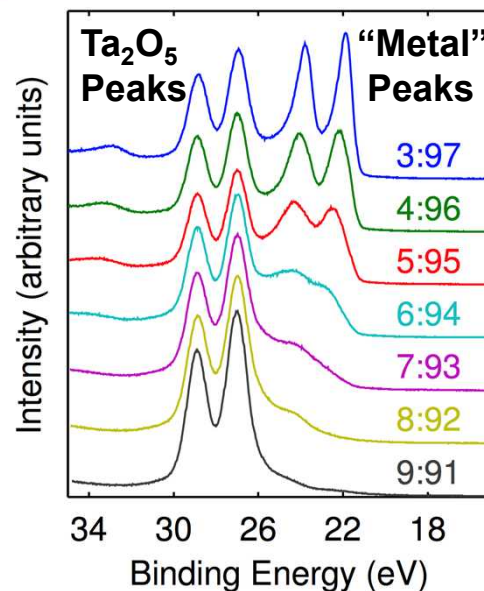
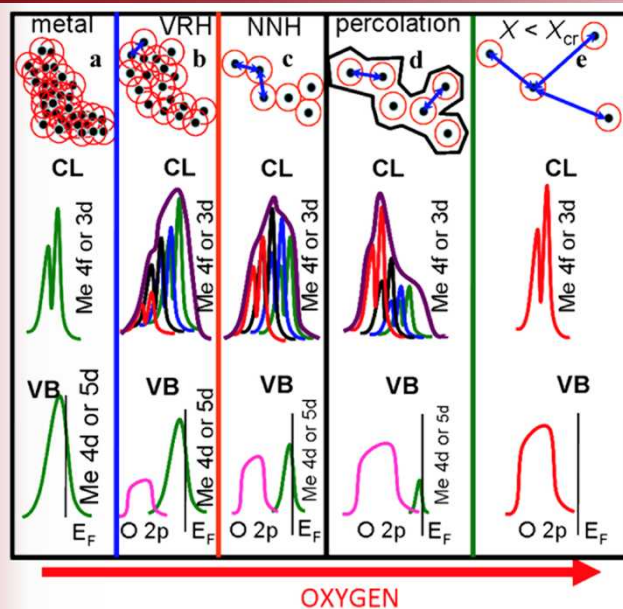


Van der Pauw: Elec. Conductivity



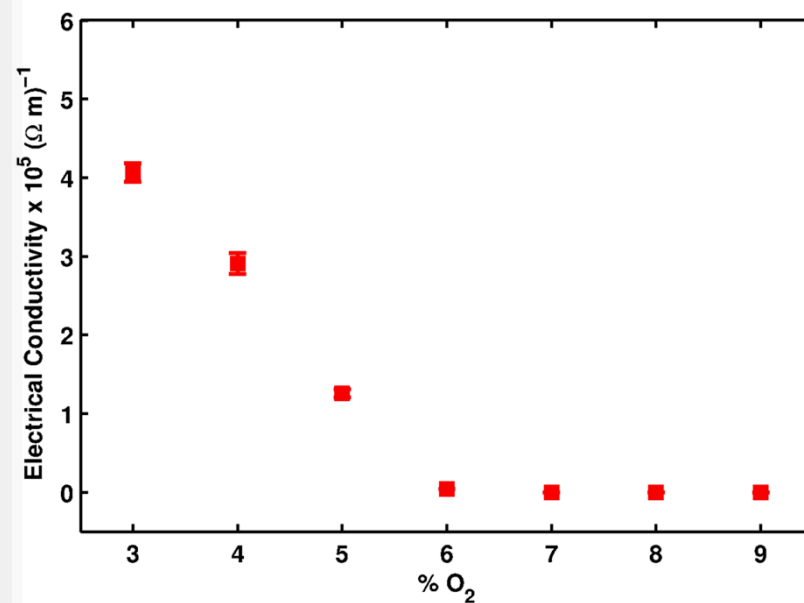
Stoichiometry & Resistivity

Stoichiometry

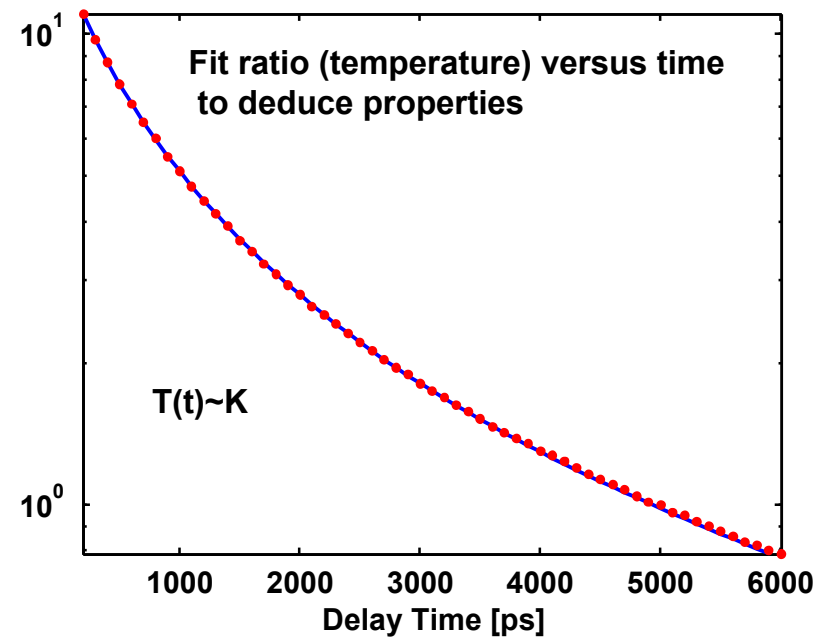
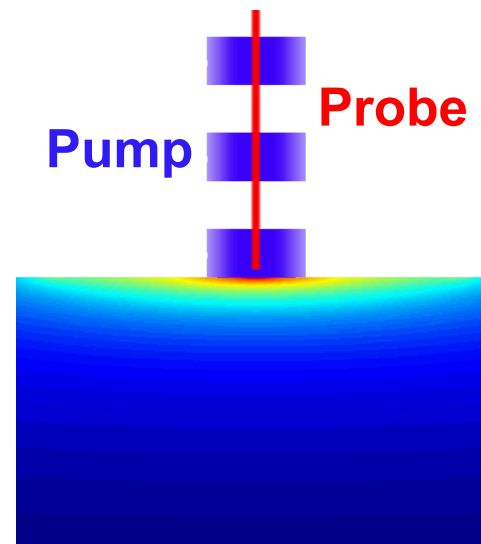
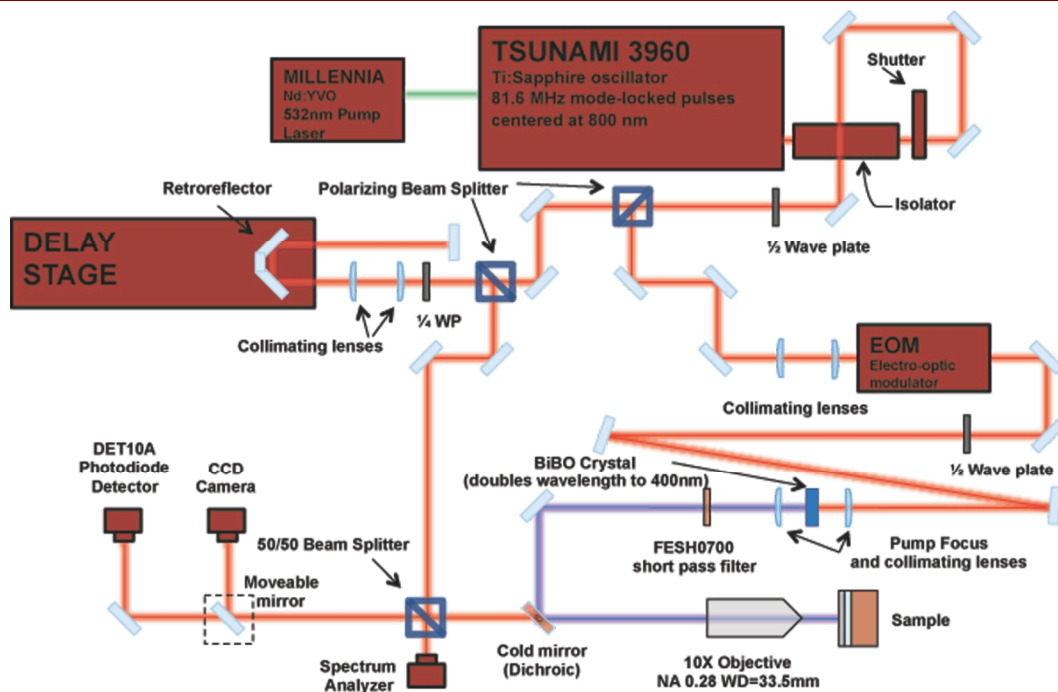


Left: Goldfarb et al. Apl. Phys. A (107) 1 2012

Conductivity

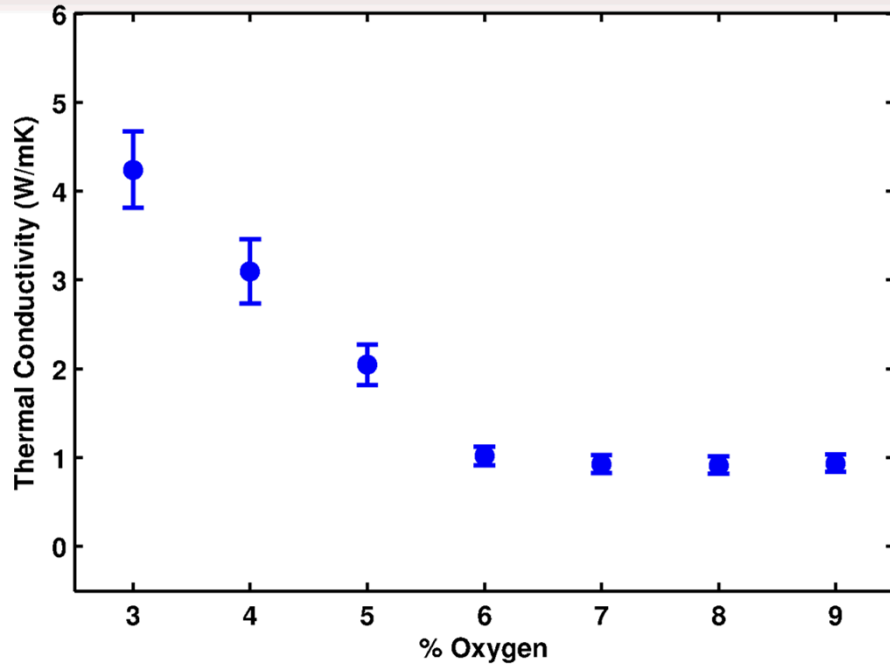


Technique: Time Domain ThermoReflectance (TDTR)

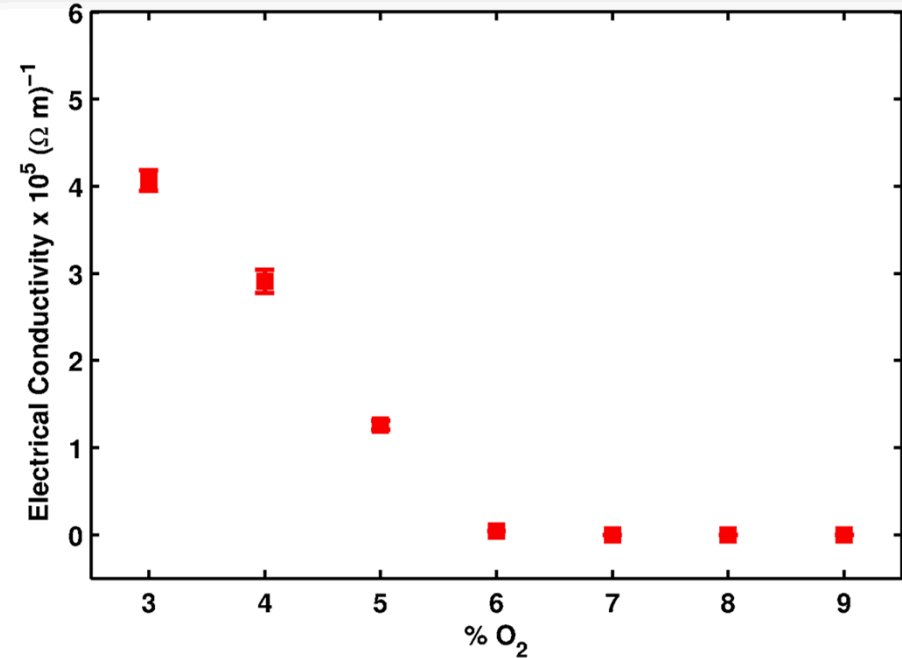


Oxygen Impact on Thermal Cond.

Thermal



Electrical

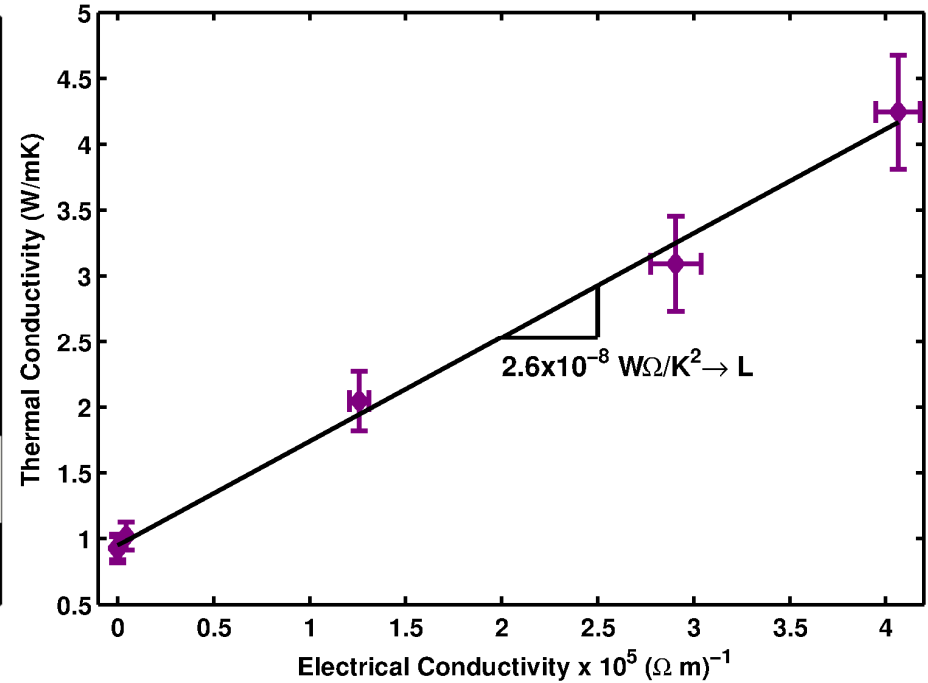
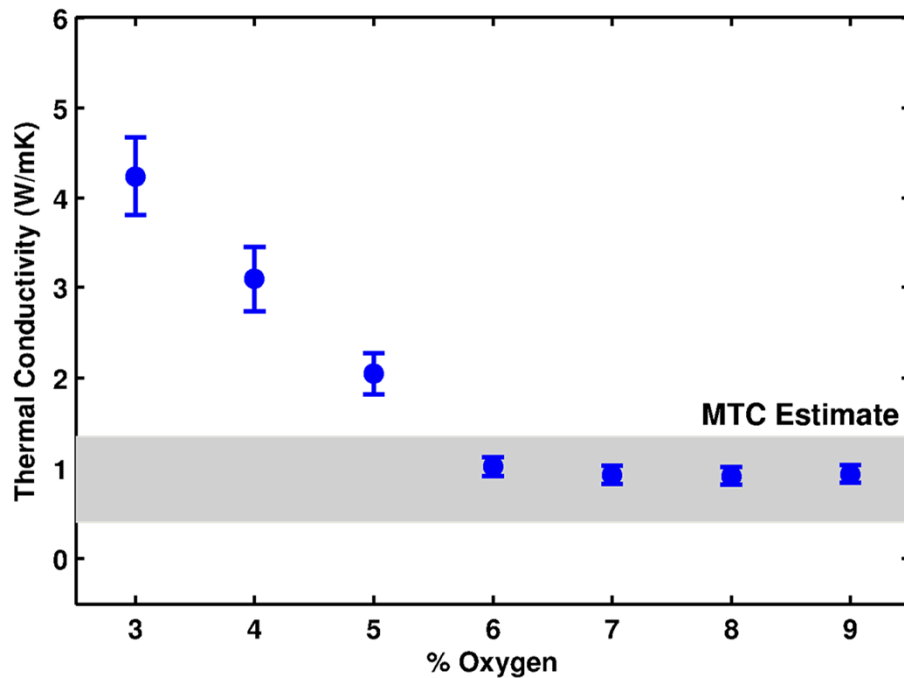


Takeaways

1. 4X Modulation with reduction in O₂
2. Thermal & Electrical Transport Linked...How?

Charge & Vibration Move Heat

$$\kappa_{tot} = \kappa_{vib} + \kappa_{elec}(O_2)$$



Takeaways

1. Dominant Heat Carrier Changes with Oxygen
2. Simple Model: Measure Resistivity Predict Thermal Conductivity

Take Home Message

APPLIED PHYSICS LETTERS 107, 023108 (2015)

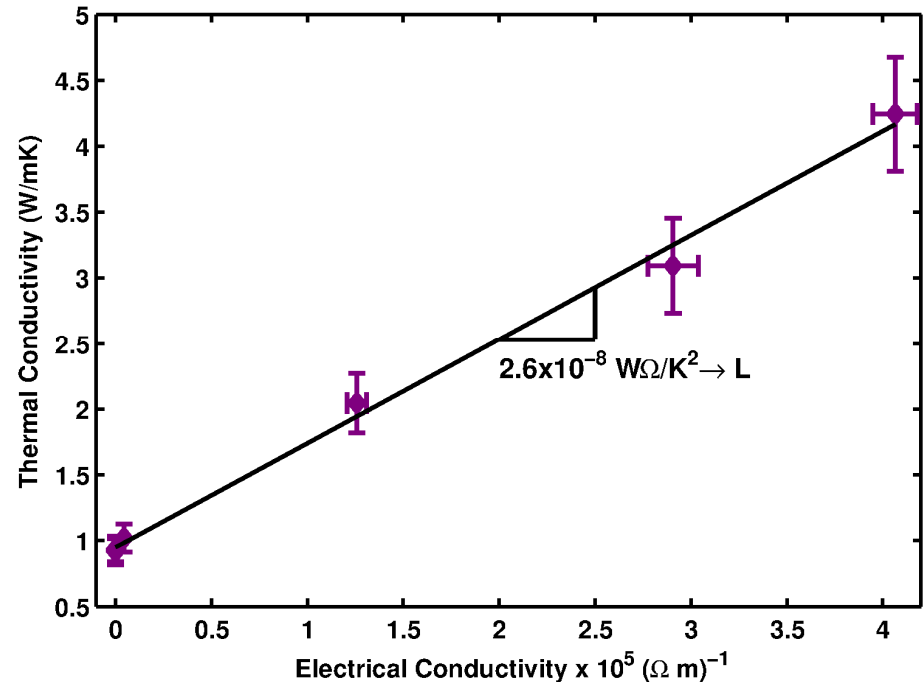
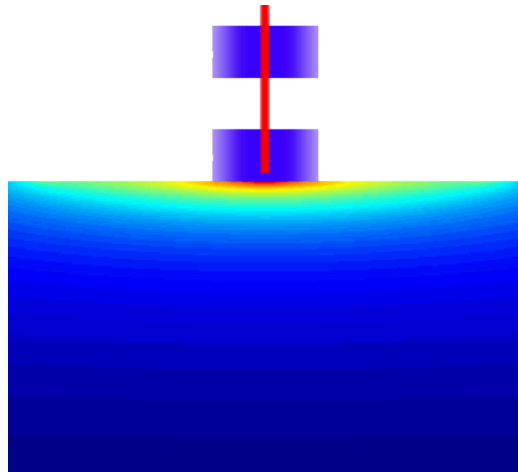
Thermal transport in tantalum oxide films for memristive applications

Colin D. Landon,¹ Rudeger H. T. Wilke,¹ Michael T. Brumbach,¹ Geoff L. Brennecke,²
Mia Blea-Kirby,¹ Jon F. Ihlefeld,¹ Matthew J. Marinella,¹ and Thomas E. Beechem¹

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1. Stoichiometry alters thermal conductivity by >4X
2. Thermal conductivity can be estimated via resistivity measurement

“Thermal” Memristor is Possible